TMDLs FOR CHLORIDE, SULFATE, TDS, AND AMMONIA IN THE ELCC TRIBUTARY, ARKANSAS

(Reach 08040201-606)

October 3, 2002

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Prepared for

EPA Region VI
Watershed Management Section
Dallas, TX 75202

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EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of a pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be allocated to point sources and nonpoint sources discharging to the waterbody.

The El Dorado Chemical Company (ELCC) Tributary, which is located in Planning Segment 2D, flows into Flat Creek, which flows into Haynes Creek, which is a tributary of Smackover Creek in south central Arkansas in the Gulf Coastal Plain Ecoregion. The designated beneficial uses that have been established by the Arkansas Department of Environmental Quality (ADEQ) for all parts of the ELCC Tributary are seasonal Gulf Coastal fishery; secondary contact recreation; and domestic, industrial and agricultural water supply. Where the drainage area is 10 mi^2 or more, the designated uses also include perennial Gulf Coastal fishery and primary contact recreation (ADEQ 2000).

The numeric standards that apply to the ELCC Tributary for chlorides, sulfates, and total dissolved solids (TDS), are 19, 41, and 138 mg/L, respectively. ADEQ's historical water quality data for the ELCC Tributary show that the chloride, sulfates, and TDS standards are frequently exceeded. Because of this, the ELCC Tributary (reach 08040201-606) was included on the Arkansas 1998 303(d) list for not supporting aquatic life and water supply uses due to effluent and runoff from ELCC and nonpoint pollution from historical oil exploration activities in the watershed (ADEQ 2000).

Historical water quality data from ADEQ monitoring stations OUA137A through I during two time periods in the basin were analyzed and plotted to examine relationships, seasonal patterns, and long-term trends.

TMDLs for dissolved minerals (chlorides, sulfates, and TDS) were developed for the ELCC Tributary based on mean annual conditions. Total allowable loads were calculated based on the water quality standards and estimates of average annual streamflow. The dissolved

mineral TMDLs for the ELCC Tributary included a background component, load allocations for man-induced nonpoint sources from the watershed, and an explicit margin of safety of 10%, plus wasteload allocations for three point sources (City of Norphlet, Wildwood Trailer Park, and ELCC non-stormwater outfalls) and load allocations for the ELCC stormwater discharges. The percent reductions required to meet the water quality standards for dissolved minerals in ELCC Tributary varied from 58% for chloride to 88% for TDS.

A TMDL for ammonia nitrogen was developed for the ELCC Tributary for low flow and high temperature conditions during summer and winter. The ammonia TMDL was developed to ensure that both of two conditions would be satisfied: 1) the oxygen demand from ammonia would not cause the DO standard to be violated, and 2) the instream ammonia concentrations would not exceed the EPA criteria for ammonia toxicity. Calculations and modeling showed that preventing ammonia toxicity required more stringent controls (i.e., higher percent reductions) than maintaining the DO standard. The ammonia TMDL was developed for both summer and winter and included wasteload allocations for the City of Norphlet, Wildwood Trailer Park, and ELCC non-stormwater discharges. An implicit margin of safety was incorporated through conservative assumptions. The ammonia concentrations for the ELCC non-stormwater discharges (outfalls 001 and 003) will need to be reduced by almost 98% during summer and 95% during winter.

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1.0 INTRODUCTION

The ELCC Tributary, which is located in Planning Segment 2D, flows into Flat Creek, which combines with Salt Creek to form Haynes Creek, a tributary of Smackover Creek within the Ouachita River Basin in hydrologic unit code (HUC) 08040201. An additional RF-1 river reach number was created for El Dorado Chemical Company (ELCC) Tributary as reach 606. The ELCC Tributary is located in south central Arkansas in the Gulf Coastal Plain ecoregion. The Arkansas Department of Environmental Quality (ADEQ) has established numeric water quality standards for chlorides, sulfates, and total dissolved solids (TDS) to protect the designated use of domestic, industrial, and agricultural water supply. The standards for chlorides, sulfates, and TDS are 19, 41, and 138 mg/L, respectively. Because the chlorides, sulfates, and TDS standards are exceeded frequently in the watershed, the ELCC Tributary (reach 606) was included on the Arkansas 1998 303(d) list for not supporting the aquatic life and water supply uses due to effluent and runoff from the ELCC and historical oil exploration activity (ADEQ 2000). Reach 606 was also listed for impairment of the aquatic life use due to ammonia toxicity. Therefore, the development of TMDLs for chloride, sulfates, TDS, and ammonia was required. These TMDLs were developed under Environmental Protection Agency (EPA) Contract #68-C-99-249, Work Assignment #2-124.

2.0 BACKGROUND INFORMATION

2.1 General Description

The ELCC Tributary is located in south central Arkansas in the Gulf Coastal Plain Ecoregion (Figure 2.1). The ELCC Tributary is in US Geological Survey (USGS) HUC 08040201 and ADEQ Planning Segment 2D. About 0.4 miles southeast of Norphlet, the unnamed tributary from El Dorado Chemical Company joins Flat Creek. The total drainage area of the basin at the confluence of ELCC Tributary and Flat Creek is approximately 22.8 mi^2 (USGS 1979), all of which is in Union County.

The ELCC Tributary watershed consists of a coastal plain of rolling terrain broken by stream valleys. Streams meander and are of moderate to low gradient (all less than 10 ft/mi). Substrate types are dominated by sand mixed with mud and silt, and rounded small sized gravel.

The soils in the basin are broadly classified as ultisols (SCS 1982) which are usually associated with forest vegetation and which have moderate to high permeability, argillic horizons, and low base saturations. The upland area soils are represented by the Briley, Darden, Harleston, Rosalie, Warnock, and Smithdale map units. Bibb and Guyton loams soils are found predominantly in the flood plains.

Of particular interest for this study is the Oil Wasteland-Fluvaquent complex, found on flood plains of local drainages and major streams. Mapped areas range from 20 to 1000 acres in size. Sixty percent of the mapped areas consist of oil and wasteland soils that have been impacted by oil and saltwater, typically lack plant cover, and are severely eroded. Even though these soils have been affected by oil waste and salt water runoff, they support salt water grasses and cattails.

2.2 Land Use

Land use in the ELCC Tributary basin is predominantly forest and pasture with some urban development. Historically, oil and gas development has occurred in the basin in the forest and wetland areas (Figure 2.2). Approximate percentages of each land use are shown in Table 2.1.

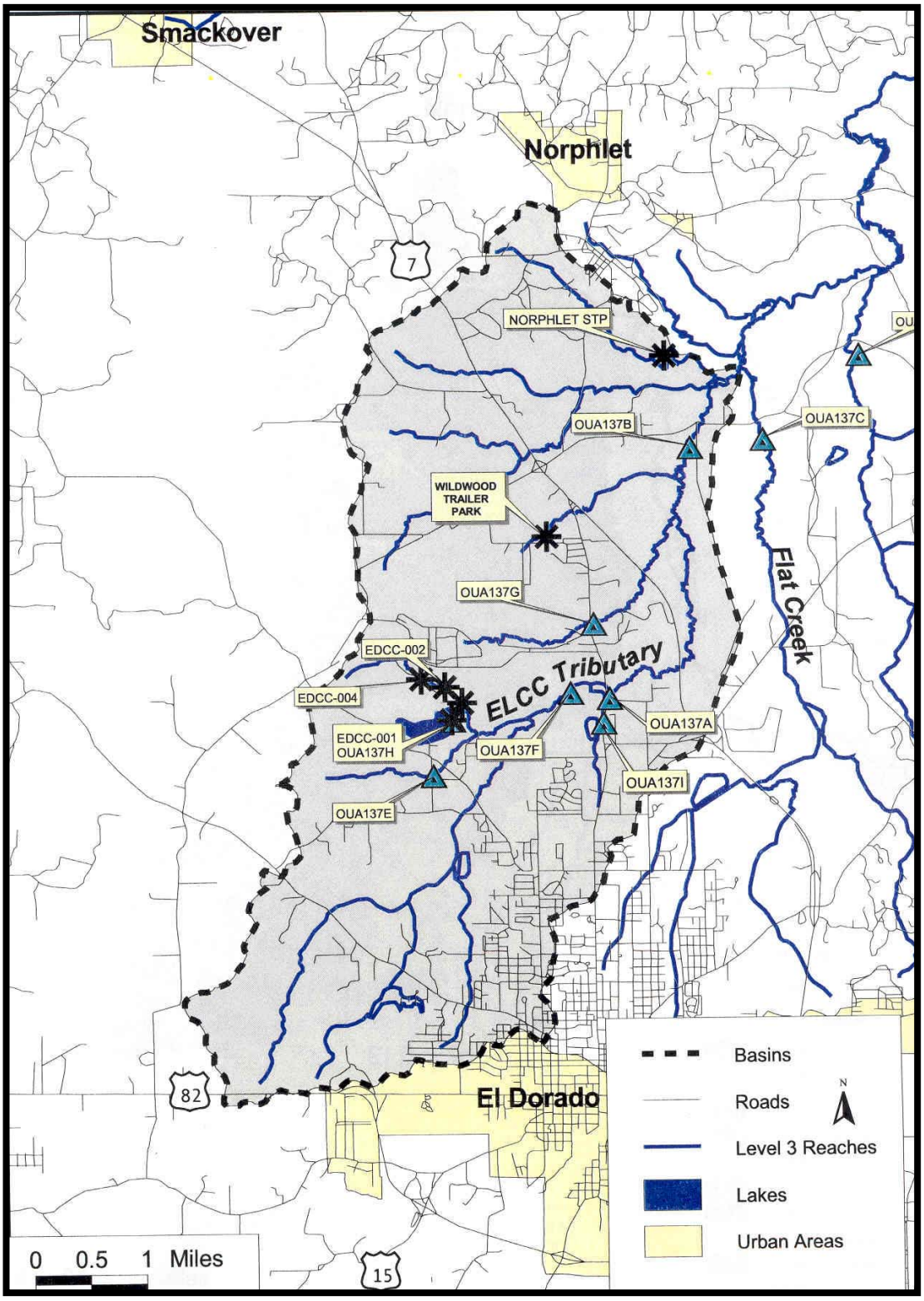

Figure 2.1. ELCC Tributary basin.

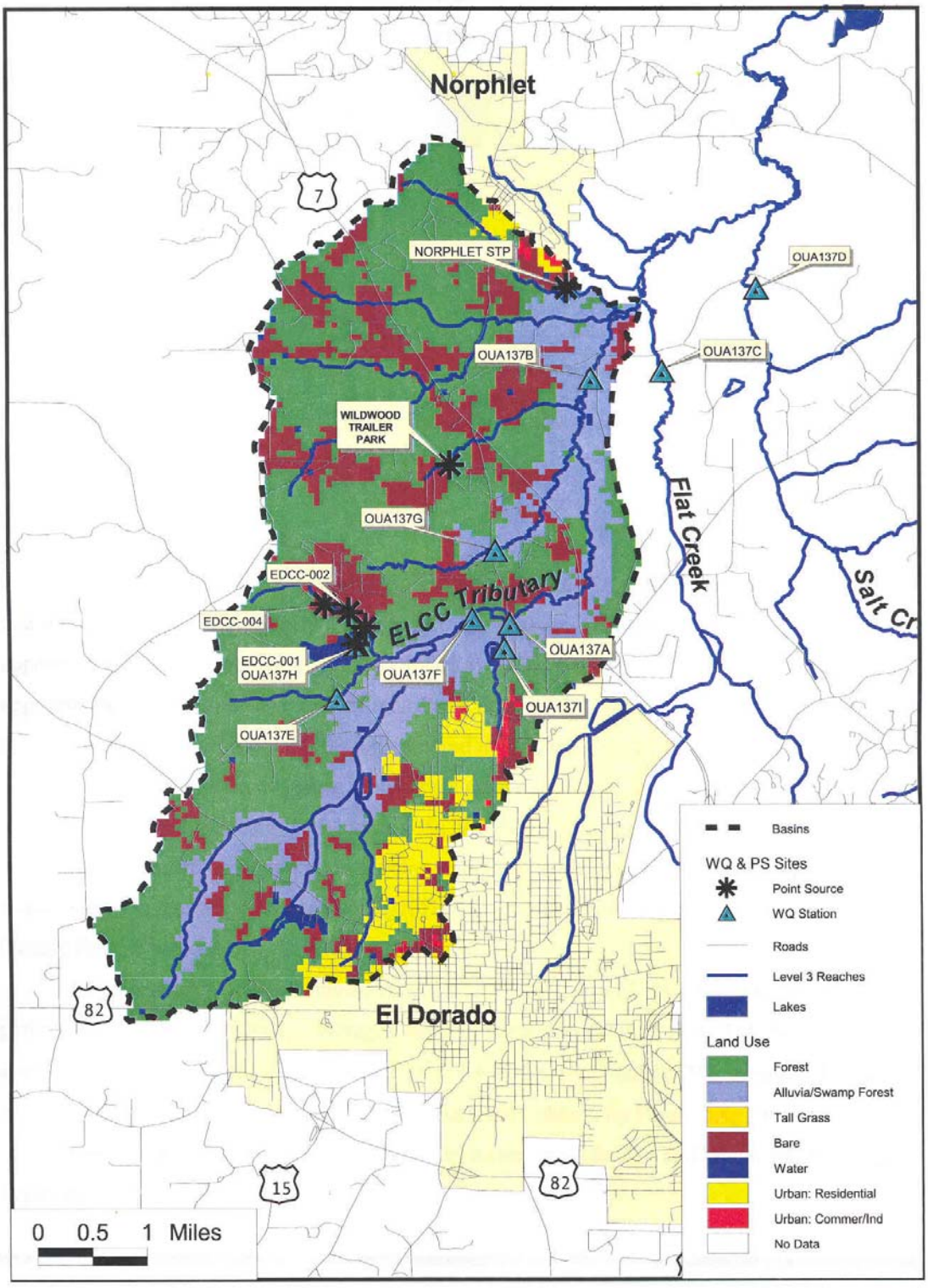

Figure 2.2. Land use.

Table 2.1. Land uses in the ELCC Tributary basin.

	ELCC Tributary (Reach 606)
Alluvial/Wetland Forest	17.9%
Forest	56.5%
Bare	18.4%
Water	1.2%
Urban Residential	5.5%
Urban Commercial	0.5%
Total	100.0%

Prior to development, the ELCC Tributary basin was predominantly bottomland hardwood forest.

2.3 Hydrology

A search for USGS flow monitoring gages within the ELCC Tributary basin indicated that there were no active or inactive flow gages. The nearest, most relevant USGS flow gage appears to be USGS Gage No. 07362100 (Smackover Creek near Smackover, AR). It is located approximately 8 miles northwest of the study area in the Gulf Coastal Plain ecoregion and has a drainage area of 385 mi^2 (USGS 2000) (compared to 22.8 mi^2 (USGS 1979) for the ELCC Tributary basin). Based on this gage, the average annual runoff for the ELCC Tributary basin is estimated to be approximately 15.0 inches (USGS 2000). The seasonal distribution of flow based on this gage is shown on Figure 2.3. Low flow months occur in late summer and high flow months occur in late winter to early spring. The 7Q10 critical low flows for ELCC Tributary are 0 cubic feet per second (cfs) (USGS 1992).

Precipitation data were obtained from the NWS station in El Dorado, which had a long period of record (1930 to 2000). Average annual precipitation for the ELCC Tributary basin is approximately 51.8 inches (Hydrosphere 2001) of which approximately 29% is runoff. Mean monthly precipitation totals for the El Dorado station are shown on Figure 2.4. The mean monthly precipitation values are highest from December through May and lowest for August and September.

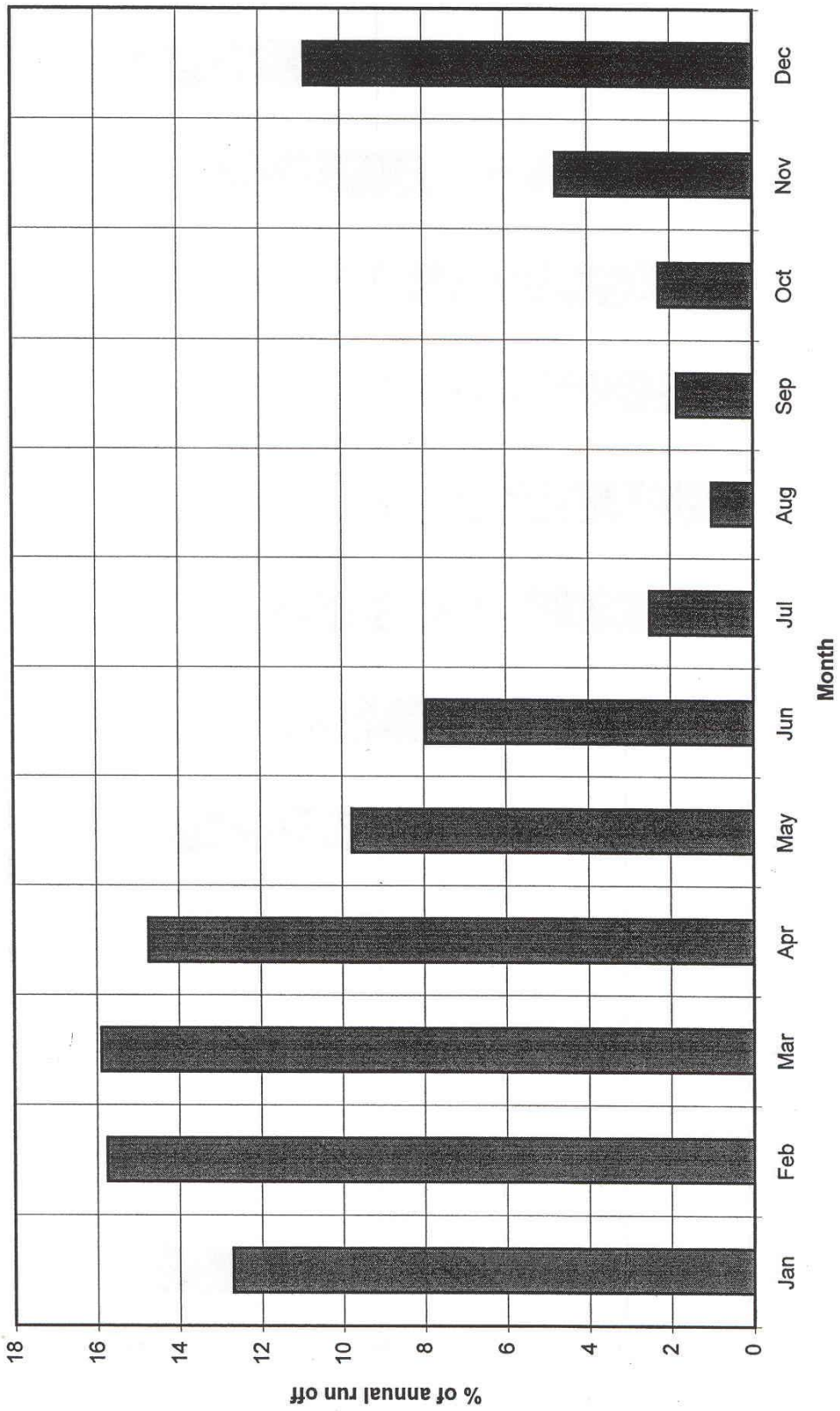

Figure 2.3. Seasonal distribution of flow for Smackover Creek near Smackover.

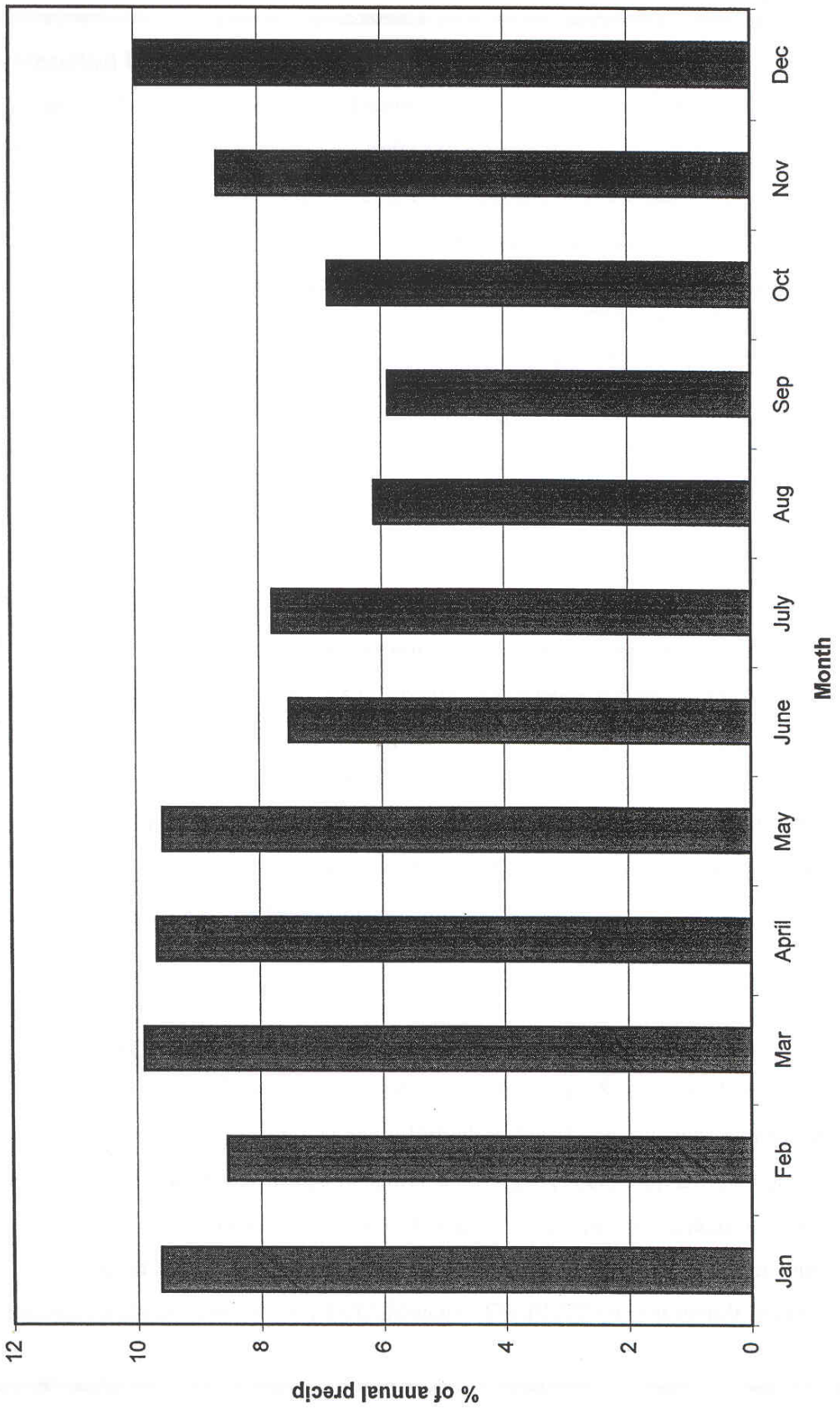

Figure 2.4. Monthly distribution of rainfall in El Dorado, Arkansas.

2.4 Designated Uses and Water Quality Standards

The State of Arkansas has developed water quality standards for waters of the state (ADEQ 2001). The standards are defined according to ecoregions and designated uses of the waterbodies. The ELCC Tributary basin lies entirely within the Gulf Coastal Plain ecoregion. Designated beneficial uses for the ELCC Tributary basin include seasonal Gulf Coastal fishery; secondary contact recreation; and domestic, industrial, and agricultural water supply. Where the drainage area is 10 mi^2 or more, the designated uses also include perennial Gulf Coastal fishery and primary contact recreation.

Dissolved mineral standards (i.e., chlorides, sulfates, and TDS) are addressed in Section 2.511 of the Arkansas Water Quality Standards (ADEQ 2001). The specific standards for the ELCC Tributary basin are:

CL – 19 mg/L
SO4 – 41 mg/L
TDS – 138 mg/L

There are no specific standards for ammonia. High ammonia concentrations can, however, impair the designated fishery uses by creating an oxygen demand that lowers instream oxygen levels to below specified dissolved oxygen (DO) standards in Section 2.505 and by being toxic and violating the narrative criteria in Section 2.508. The DO standards for the ELCC Tributary basin during the critical season are 2 mg/L for watersheds less than 10 mi^2 and 3 mg/L for watersheds greater than 10 mi^2 and less than 500 mi^2. For the primary season, the DO standard is 5 mg/L (regardless of watershed size).

2.5 Point Sources

Information on point source discharges in the ELCC Tributary basin (within HUC 08040201) was obtained by searching the Permit Compliance System (PCS) on the EPA website, reviewing ADEQ files, and reviewing information found in published technical reports. The search yielded three facilities with point source discharges (Table 2.2). Effluent data from the three facilities is summarized in Appendix A. Locations of the permitted facilities are shown on Figure 2.1. Based on ADEQ (1998), the El Dorado Chemical Company is a major source of

dissolved minerals and ammonia to the ELCC Tributary. The ELCC current permit was renewed effective on May 31, 2002; previously the facility had been discharging under a Consent Administrative Order dated October 10, 1998.

2.6 Nonpoint Sources

Nonpoint sources of pollution in the watershed have been discussed in the latest 305(b) report (ADEQ 2000). ADEQ suggests that nonpoint source pollution is due to oil exploration activities from past and present. This is confirmed by the description of the soils in Section 2.1. There is no significant agricultural development with most of the land either being used for oil exploration or for timber for the forestry industry.

2.7 Previous Water Quality Studies

The following is a list of relevant water quality studies that were identified for the ELCC Tributary basin:

1. ADEQ. 1998. TMDL Investigation of Water Quality Impairment to Unnamed Tributary to Flat Creek, Union County, Arkansas. WQ-98-04-1. Published by Arkansas Department of Environmental Quality.
2. FTN. 1991. Surface Water Quality Study for El Dorado Chemical Company. Prepared by FTN for El Dorado Chemical Company.

Table 2.2. Summary of point source discharges in ELCC Tributary basin.

NPDES PERMIT NUMBER	FACILITY NAME	Design Flow (MGD)	Receiving Streams	Outfalls	PARAMETER	Monthly Average Limit
AR0044733	Wildwood Trailer Park	0.031	Tributary to Flat Creek	001	TSS	30 mg/L
					Total Ammonia Nitrogen (summer)	5 mg/L
					Total Ammonia Nitrogen (winter)	13 mg/L
					Fecal Coliform	1000 N/ml
					CBOD, 5 day	20 mg/L
AR0035653	City of Norphlet	0.18	Tributary to Flat Creek	001	TSS	30 mg/L
					Total Ammonia Nitrogen	6 mg/L
					Fecal Coliform	1000 N/ml
					CBOD, 5 day	20 mg/L
AR0000752	El Dorado Chemical Co.			001	TSS	30 mg/L
					Ammonia Nitrogen	
					Nitrate Nitrogen	
					DO (June-October)	4 mg/L
					DO (November-May)	6 mg/L
					Sulfates	
				002	Oil and Grease	10 mg/L
					Ammonia Nitrogen	
					TSS	
				003	CBOD	25 mg/L
					TSS	30 mg/L
					Ammonia Nitrogen (May-October)	10 mg/L
					Ammonia Nitrogen (November-April)	15 mg/
					Fecal Coliform	1000 N/ml
				004	Oil and Grease	15 mg/L
					Ammonia Nitrogen	
					TSS	

3.0 CHARACTERIZATION OF EXISTING WATER QUALITY

3.1 Inventory of Data

Information on water quality monitoring stations in ELCC Tributary basin (within HUC 08040201) was obtained by searching the EPA STORET database and from reviewing technical reports of studies in the area. The search was conducted for data collected by all agencies at all water quality stations on ELCC Tributary streams in the previously mentioned HUC code. The search yielded only the stations that were included in the ADEQ report (ADEQ 1998). One USGS water quality monitoring station was found near the watershed. Data for that station (07362203, Haynes Creek near Norphlet) were retrieved from the USGS website but included only three sampling events for chloride, sulfate, and TDS.

3.2 Assessment Reports

The most relevant data for this study were collected by ADEQ and documented in a report titled "TMDL Investigation of Water Quality Impairment to Unnamed Tributary to Flat Creek, Union County, Arkansas" (ADEQ 1998). Water quality data were collected by ADEQ from 9 sampling locations on several occasions throughout the watershed from January 1995 to July 1996 and from March 1997 to December 1997. Parameters measured included flow, sulfates, chlorides, TDS, ammonia, and a suite of other parameters including biological data (Appendix B). These data were used to support this TMDL. The ADEQ report summarizes these data and presents the following conclusions:

a. "Water quality data demonstrates problem areas of minerals, heavy metals, ammonia, and nitrates."

b. "The ELCC tributary exhibits substantially elevated sulfate and total dissolved solids; … consistent, in-stream toxic affects to test organisms existed; and impairment of the indigenous biota of the stream was identified."

c. "Flat Creek receives elevated levels of sulfates and TDS from the ELCC tributary and very high levels of chlorides from its upstream watershed."

d. "Stormwater runoff from the north side of the ELCC plant results in toxic levels of copper, zinc, and ammonia in the tributary stream approximately 1 mile below the facility."

e. "Toxicity was strongly correlated with in-stream pH and was much more severe on the minnow than the *Ceriodaphnia*, thus indicating ammonia as the primary toxic compound.

ADEQ (1998) also indicated that in October 1994, the ELCC submitted a request to the ADEQ to modify the water quality standard for dissolved minerals for several streams in the Flat Creek/Salt Creek basin and to increase its ammonia discharge limits. The request was denied due to concerns about aquatic life impairment in the ELCC Tributary (ADEQ 1998). Field data and modeling studies supporting the request are found in FTN (1991).

3.3 Data Analysis

3.3.1 Dissolved Minerals

Table 3.1 summarizes the dissolved minerals data collected by ADEQ (1998) for representative stations for the reach of interest in this study (08040201-606). Data for all the ADEQ stations are summarized in Appendix B. In the ELCC Tributary to Flat Creek, dissolved minerals concentration exceeded water quality standards (WQS) the majority of the time, with some dilution occurring moving downstream from Stations OUA137F and OUA137A to OUA137B (Figures 3.1 through 3.3, located in Appendix C). Station OUA137E was located upstream of the ELCC facility and also exhibited high TDS and chloride concentrations (Appendix B) that routinely exceeded WQS. Sulfate concentrations at Station OUA137E were less than the WQS. Although the data are limited, comparisons of data from OUA137E (located upstream of ELCC) with stations OUA137G and OUA137A (located downstream of ELCC) clearly indicate ELCC to be a source of high dissolved minerals both from point and nonpoint sources.

3.3.2 Ammonia

The ELCC Tributary was also on the 303(d) list for ammonia toxicity and impairment of its aquatic life uses. Ammonia concentrations for the ELCC Tributary are summarized in Table 3.2. Compared to concentrations in Flat and Salt Creeks, ammonia concentrations in the ELCC Tributary are at least an order of magnitude higher. As with dissolved minerals, comparison of

concentrations from the upstream station (OUA137E) with downstream stations indicate the ELCC facility as both a point and a nonpoint source contributor of ammonia.

Table 3.1. Summary of instream dissolved mineral data.

	ELCC Unnamed Tributary (08040201-606)		
	OUA137A	**OUA137B**	**OUA137F**
Chloride (mg/L)			
Period of Record for statistics	1/95 to 12/97	1/95 to 12/97	1/95 to 12/97
Number of samples	12	12	4
Minimum	20.1	15.0	23.8
Maximum	71.9	63.6	70.1
Median	32.8	26.7	33.3
Number above standards	12	9	4
Percent above standards	100%	75%	100%
Sulfate (mg/L)			
Period of Record for statistics	1/95 to 12/97	1/95 to 12/97	1/95 to 12/97
Number of samples	12	12	4
Minimum	47.6	33.4	49.8
Maximum	700	2970	412
Median	124	63.6	77.1
Number above standards	12	10	4
Percent above standards	100%	83%	100%
TDS (mg/L)			
Period of Record for statistics	1/95 to 12/97	1/95 to 12/97	1/95 to 12/97
Number of samples	12	12	4
Minimum	206	159	307
Maximum	1,589	1,447	1,373
Median	372	444	355
Number above standards	12	12	4
Percent above standards	100%	100%	100%

Table 3.2. Summary of instream ammonia data.

	ELCC unnamed Tributary (08040201-606)			Flat Creek (08040201-706)	Salt Creek (08040201-806)
	OUA137A	OUA137B	OUA137F	OUA137C	OUA137D
Period of Record for statistics	1/95 to 12/97	1/95 to 12/97	1/95 to 12/97	1/95 to 12/97	1/95 to 12/97
Number of samples	12	12	8	11	12
Minimum	5.55	2.25	6.8	0.025	0.025
Maximum	54.1	48.3	72	4.74	0.709
Median	20.2	9.7	33.2	0.20	0.067

4.0 TMDL DEVELOPMENT

4.1 Dissolved Minerals

In this section, the TMDLs for dissolved minerals (chlorides, sulfates, and TDS) for the ELCC Tributary upstream of its confluence with Flat Creek are developed. It is assumed that successful implementation of the TMDL for upper Flat Creek and the ELCC Tributary will result in the lower part of Flat Creek meeting water quality standards. Printouts of the spreadsheets with the TMDL computations are included in Appendix D.

4.1.1 Seasonality and the Determination of Critical Conditions

The historical data and analyses discussed in Section 3.0 were used to evaluate whether there were certain flow conditions, spatial locations, or certain periods of the year that could be used to characterize critical conditions. Although dissolved mineral concentrations appeared to be slightly higher during the summer low flow months, no significant relationships were found for dissolved minerals with flow or season. Sources of dissolved minerals in the ELCC Tributary include both point sources and nonpoint sources, indicating all seasons are important. The exceedances of water quality standards for dissolved minerals occurred fairly uniformly throughout the year in the ELCC Tributary. Also, Arkansas's water quality standards for dissolved minerals are not seasonal. Due to year-round standards and limited data, including no flow data, no critical conditions were identified for the dissolved minerals TMDLs for the ELCC Tributary and mean annual conditions were used.

Because there are point sources contributing dissolved minerals during low flow conditions, permit limits for those point sources will need to be evaluated under critical low flow conditions. Since development of point source permit limits for different flow conditions was considered to be part of the implementation of the TMDL, it is not included here.

4.1.2 Linking Water Quality and Pollutant Sources

The high dissolved mineral concentrations in the ELCC Tributary have been attributed to point source discharges and stormwater runoff from ELCC (ADEQ 1998). Historical oil field

development that left oil waste and salt water must also be considered as a source. Chlorides, TDS, and sulfates concentrations exceeded water quality standards in the ELCC Tributary in the majority of the samples collected. Exceedances of the chlorides and TDS standards at station OUA137E (upstream of ELCC) indicate other nonpoint sources of pollution in addition to ELCC. Since concentrations appear to decrease in a downstream direction, sources of high dissolved minerals appear to be located in the upper reaches of the watershed.

4.1.3 Current Load

Current loads of dissolved minerals for the ELCC Tributary were calculated using the average instream dissolved mineral concentrations and the average annual flow for the stream. The following equation was used to compute the loads:

Load in lbs/day = C x Q x 8.34
where C = concentration in mg/L and Q = flow in MGD.

Mean annual conditions were used since the limited available data did not indicate any significant seasonality or critical conditions. For the concentrations, averages of the data collected at station OUA137B were used. The mean annual flow was estimated by using the watershed area of the ELCC Tributary at its confluence with Flat Creek and multiplying it by the mean annul runoff for the USGS gage at Smackover (i.e., 15 inches per year).

Because the City of Norphlet's discharge enters the ELCC Tributary downstream of station OUA137B, its loads were added to the loads calculated for station OUA137B. The City of Norphlet loads were calculated using average flows from DMRs and typical concentrations for treated municipal wastewater. These typical concentrations were based on information in EPA (1997) and Metcalf and Eddy (1979) and their values were 70 mg/L chlorides, 45 mg/L sulfates, and 500 mg/L TDS. These calculations are shown in Table D.1 (in Appendix D).

4.1.4 TMDL

The allowable loads (i.e., TMDLs) for dissolved minerals were calculated by multiplying the existing water quality standards (Section 2.4) by the same mean annual flow that was used to calculated current loads. The calculations are shown in Table D.2 and the results are included in Table 4.1.

Table 4.1. Dissolved minerals TMDL for ELCC Tributary (08040201-606).

	ELCC Tributary		
	Chlorides (lbs/day)	**Sulfates (lbs/day)**	**TDS (lbs/day)**
WLA for Wildwood Trailer Park	18	12	129
WLA for City of Norphlet	105	68	751
WLA for ELCC non-stormwater	265	503	1,338
LA for ELCC stormwater	73	33	635
LA for man-induced watershed NPS	1,243	2,775	5,816
LA for background sources	671	1,746	8,996
MOS	176	368	865
TMDL	2,551	5,505	18,530
Percent reduction for ELCC and man-induced watershed NPS	58%	86%	88%

4.1.5 Wasteload Allocations and Load Allocations

The sources of dissolved minerals for the ELCC Tributary were grouped as follows:

- Background loads
- City of Norphlet and Wildwood Trailer Park
- ELCC non-stormwater outfalls (001 and 003) - considered as point source
- ELCC stormwater outfalls (002, 004, 005, 006, and 007) - considered as NPS
- Man-induced nonpoint source loads from the watershed

The background loads were calculated using the ADEQ reference stream data for the Gulf Coastal Plain ecoregion (from the ADEQ Continuing Planning Process (CPP) document) and the mean annual flow rate for the ELCC Tributary. Calculations for background loads are included in Table D.3.

The wasteload allocations (WLAs) for the City of Norphlet and Wildwood Trailer Park were set based on current design flows and the typical dissolved mineral concentrations for treated municipal wastewater presented above (70 mg/L chlorides, 45 mg/L sulfates, and 500 mg/L TDS). The current design flows obtained from EPA's Permit Compliance System (PCS) were 0.18 MGD for the City of Norphlet and 0.031 MGD for Wildwood Trailer Park. No reductions were proposed for these point sources because their discharges are small. Calculations for these two WLAs are shown in Table D.3.

The three sources that were targeted for reductions were ELCC non-stormwater discharges, ELCC stormwater discharges, and man-induced nonpoint source contributions from the watershed. The WLAs and LAs for these three sources were determined based on a uniform percent reduction for all three sources. The percent reduction for these sources was calculated as outlined in the following steps (calculations are shown in Table D.4):

1. The total current loads for the ELCC Tributary were calculated as described in Section 4.2.3 and the TMDLs were calculated as described in Section 4.2.4.
2. The combined current loads for the three sources targeted for reduction were computed using the following equation:

$$\text{Combined current load for 3 targeted sources} = \text{ELCC trib total current load} - \text{Background load} - \text{Norphlet WLA} - \text{Wildwood WLA}$$

3. For the three sources targeted for reduction, the maximum allowable combined loads to maintain standards were computed from the following equation (which incorporates an explicit margin of safety that is 10% of the three targeted sources):

$$\text{Combined allowable load for 3 targeted sources} = \left[\text{TMDL} - \text{Background load} - \text{Norphlet WLA} - \text{Wildwood WLA} \right] \times 90\%$$

4. The percent reduction for each constituent was then calculated from the results of the previous two steps:

$$\text{Percent reduction} = 100\% \times \left[\text{Combined current load} - \text{Combined allowable load} \right] \div \text{Combined current load}$$

For each constituent, the combined allowable load for the three targeted sources was divided among the three sources proportional to their current loads. The current loads for the ELCC non-stormwater discharges were calculated using the combined design flows for Outfalls 001 and 003 (which were back calculated from mass and concentration permit limits) and average concentrations from DMRs and from field studies during 1991 (calculations are shown in Table D.5).

For the ELCC stormwater discharges, the current loads were calculated based on an estimated annual volume of runoff and average concentrations from observed data. The annual volume of runoff was estimated by multiplying the size of the manufacturing area within the ELCC facility (approximately 300 acres according to FTN 1991) times the average annual runoff for the USGS gage on Smackover Creek (15 inches). The average concentrations of dissolved minerals for the ELCC stormwater outfalls were computed by averaging all available data for each outfall (from DMRs and from field studies during 1991) and then taking the averages for all of the outfalls (calculations are shown in Table D.6).

The current load for man-induced nonpoint source contributions from the watershed was then estimated as the remainder of the combined current load for the three targeted sources (calculations are shown in Table D.7):

$$\text{Current load for man-induced w'shed NPS} = \text{Combined current load for 3 targeted sources} - \text{Current ELCC non-storm load} - \text{Current ELCC stormwater load}$$

4.1.6 Margin of Safety

Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7 require the inclusion of a margin of safety (MOS) in the development of a TMDL. For the dissolved minerals TMDLs for the ELCC Tributary, the explicit MOS was set to 10% of the loads targeted for reduction.

4.2 Ammonia

The TMDL for ammonia for the ELCC Tributary is based on maintaining the applicable DO standard as well as not exceeding EPA's criteria for ammonia toxicity. The maximum allowable ammonia concentrations to maintain the DO standard were based on a calibrated QUAL2E model that was developed in a previous study (FTN 1991). The documentation for the QUAL2E modeling is presented in Appendix E. The calculations for ammonia toxicity were based on published criteria (EPA 1999) are shown in Appendix F.

4.2.1 Seasonality and Determination of Critical Conditions

Critical conditions for the ammonia TMDL were based on the sources of ammonia in the ELCC Tributary and environmental conditions that are most critical for maintaining the DO standard and not exceeding ammonia toxicity criteria. Currently, the majority of the ammonia load to the ELCC Tributary is point source loading; critical conditions for point sources are usually characterized by low upstream flow, which causes reduced dilution. For maintaining the DO standard, critical periods are typically characterized by high temperature and low flow. High temperatures decrease DO saturation values and increase nitrification rates. Low flows provide less dilution for point source discharges and can have lower reaeration rates due to decreased velocity in the stream. For ammonia toxicity, critical conditions are usually high temperatures because the allowable instream concentrations decrease as temperature increases. Based on this information, critical conditions for the ammonia TMDL were defined as 7Q10 flows and maximum allowable water temperatures.

Because the DO standards for the ELCC Tributary are seasonal and the EPA criteria for ammonia toxicity are dependent on temperature, the ammonia TMDL was computed for both summer and winter seasons. For the summer season, the applicable DO standard is 3 mg/L (Section 2.4), the maximum allowable temperature is 30°C (ADEQ 2001), and the annual 7Q10 is zero (Section 2.3). For the winter season, the DO standard is 5 mg/L (Section 2.4), the critical temperature was set to 22°C, and the upstream flow at the ELCC outfalls was set to 1.0 cfs. The critical temperature for winter was based on requirements for meeting the DO standard during

the primary season (ADEQ 2001). The 1.0 cfs flow upstream of the ELCC outfalls was developed for seasonal conditions in a previous study (FTN 1991).

4.2.2 Linking Water Quality and Pollution Sources

The high ammonia concentrations in the ELCC Tributary have been attributed to both point source (i.e., continuous) and nonpoint source (i.e., stormwater) discharges from ELCC (ADEQ 1998). Comparison of samples at station OUA137E (upstream) with samples from downstream stations (OUA137F and OUA137A) clearly indicates ELCC to be a source of ammonia (Section 3.3.2). Data collected downstream of ELCC's stormwater outfalls (station OUA137G) also showed some elevated ammonia concentrations. Other minor sources of ammonia within the basin include treated wastewater from the City of Norphlet and Wildwood Trailer Park.

4.2.3 Maximum Allowable Concentrations

Development of the ammonia TMDL required two parallel tasks: 1) modeling to determine the maximum ammonia concentrations to maintain the DO standard, and 2) spreadsheet calculations to determine the maximum ammonia concentrations that would not exceed EPA's criteria for ammonia toxicity. The results of these two parallel tasks were compared and the results from the task with lower allowable ammonia concentrations were then used for the TMDL calculations.

The maximum allowable ammonia concentrations for maintaining the DO standard were determined from a calibrated QUAL2E model that was documented in a previous study (FTN 1991). Appendix E of this report contains excerpts from the 1991 FTN report that describe the model set up and calibration, the projection runs, and the model results. The 1991 FTN report showed that the DO standard would be maintained with ELCC outfall 001 discharging at ammonia nitrogen concentrations of 28 mg/L in summer and 38 mg/L in winter. Because the upstream flows were 0 cfs for summer and 1 cfs for winter, the instream ammonia nitrogen concentrations predicted by the model just downstream of outfall 001 were similar to the discharge concentrations.

The maximum allowable ammonia concentrations based on ammonia toxicity were calculated using EPA's most recent published criteria (EPA 1999). These criteria are dependent on temperature and pH. The pH values used in these calculations were the average pH for each season at station OUA137A (downstream of ELCC outfall 001). The temperatures used in these calculations were the same as the critical temperature discussed above (30°C for summer and 22°C for winter). The resulting maximum instream concentrations of ammonia nitrogen were 2.43 mg/L for summer and 4.17 mg/L for winter. These calculations are shown in Table F.1 (in Appendix F).

Based on the results of these two parallel tasks, the allowable ammonia concentrations are limited by ammonia toxicity rather than by maintaining the DO standard. Therefore, the ammonia TMDL was based on the ammonia toxicity calculations rather than the DO modeling. Because ammonia is not a conservative substance, the ammonia TMDL was developed by calculating individual components of the TMDL and adding them together rather than first calculating the total load for the basin and then dividing it into individual components.

4.2.4 Wasteload Allocations

Wasteload allocations for ammonia were developed for ELCC outfalls 001 and 003, the City of Norphlet, and Wildwood Trailer Park. Because ammonia is a non-conservative substance and these three facilities are located relatively far apart, each facility was considered independently. For each facility and each season, a mass balance was used to calculate the allowable discharge concentration based on the allowable instream concentration of ammonia immediately downstream of the outfall. The upstream ammonia concentration in the mass balance calculations was set to the average measured value at station OUA137E. All three facilities were assumed to have the same upstream flow because the upstream drainage areas appear to be similar in size. The mass balance calculations are shown in Table F.2.

The wasteload allocations will require reductions in ammonia concentrations for the ELCC outfalls but not for the City of Norphlet or Wildwood Trailer Park. Ammonia concentrations at ELCC outfall 001 will have to be reduced almost 98% during summer and 95% during winter in order for instream concentrations to stay below the EPA criteria for ammonia

toxicity (based on the medians of DMR concentrations for September 1999 through September 2001). The wasteload allocations and other components of the ammonia TMDL are shown in Table 4.2.

Table 4.2. Ammonia TMDL for ELCC Tributary (08040201-606).

	ELCC Tributary	
	Summer (lbs/day)	**Winter (lbs/day)**
WLA for City of Norphlet	3.65	27.01
WLA for Wildwood Trailer Park	0.63	21.82
WLA for ELCC Outfall 001	37.90	85.78
LA for watershed nonpoint sources	0.00	5.16
MOS	incorporated through conservative assumptions	
TMDL	42.18	139.77

4.2.5 Load Allocations

Load allocations for nonpoint source contributions of ammonia from the watershed were calculated by multiplying the upstream flows times the upstream concentrations in the mass balance. Because the annual 7Q10 is zero, the summer load allocation was zero. For winter, the total load allocation was 3 cfs (1 cfs upstream of each facility) times the upstream concentration (0.32 mg/L). Other winter inflows to the ELCC Tributary (i.e., farther downstream) were neglected in these TMDL calculations because they have no effect on the loadings at the critical locations in the basin (the points immediately downstream of each outfall).

The load allocations for ammonia were not divided between man-induced and natural background because the nonpoint source contributions from the watershed are small compared to contributions from point sources.

4.2.6 Margin of Safety

Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7 both require the inclusion of a margin of safety (MOS) in the development of a TMDL. An

implicit MOS was incorporated in the ammonia TMDLs through the use of conservative assumptions. These conservative assumptions include:

- Using design flows rather than typical effluent flows to calculate WLAs
- Using critical upstream flows that are exceeded most of the time
- Using critical temperatures that are rarely equaled or exceeded
- Assuming that critical low flows and critical temperatures occur simultaneously

5.0 MONITORING AND IMPLEMENTATION

In accordance with Section 106 of the Federal Clean Water Act and under its own authority, ADEQ has established a comprehensive program for monitoring the quality of the State's surface waters. ADEQ collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for long term trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (*Water Quality Inventory*) and the 303(d) list of impaired waters.

Point source reductions for these TMDLs will be implemented through the NPDES program, which is administered in Arkansas by ADEQ.

6.0 PUBLIC PARTICIPATION

When EPA establishes a TMDL, federal regulations require EPA to publicly notice and seek comment concerning the TMDL. These TMDLs have been prepared under contract to EPA. After development of these TMDLs, EPA and/or a designated state agency will commence preparation of a notice seeking comments, information, and data from the general public and affected public. If comments, data, or information are submitted during the public comment period, then EPA may revise the TMDLs accordingly. After considering public comment, information, and data, and making any appropriate revisions, EPA will transmit the revised TMDLs to the ADEQ for implementation and incorporation into ADEQ's current water quality management plan.

7.0 REFERENCES

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APPENDIX A

Summary of Point Source Effluent Data

Table A1. Summary of DMR data for El Dorado Chemical Company.

El Dorado Chemical Company											
	Ammonia (mg/L)		TSS(mg/L)		FLOW (Mgd)		CBOD5(mg/L)		DO (mg/L)	Sulfates (mg/L)	
	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	MIN	AVG	MAX
OUTFALL 001											
BEGIN DATE	9/30/99	9/30/99	9/30/99	9/30/99	9/30/99	36433			9/30/99	9/30/99	9/30/99
END DATE	9/30/01	9/30/01	9/30/01	9/30/01	9/30/01	37164			9/30/01	9/30/01	9/30/01
NUMBER OF DATA POINTS	18	18	18	18	18	18			18	18	18
MIN	57.4	69.4	2.7	3.1	0.2402	0.5370			7.0	75.0	102.0
MAX	280.0	322.0	37.0	45.6	1.4116	4.7923			10.2	485.1	704.0
MEDIAN	104.7	116.5	12.5	17.0	0.4680	1.3224			8.5	231.2	261.0
AVERAGE	121.3	149.4	13.2	19.0	0.5883	1.4642			8.5	238.7	278.2
OUTFALL 003											
BEGIN DATE	10/31/99	10/31/99	9/30/99	9/30/99	9/30/99	9/30/99	9/30/99	9/30/99			
END DATE	10/31/01	10/31/01	9/30/01	9/30/01	9/30/01	9/30/01	9/30/01	9/30/01			
NUMBER OF DATA POINTS	9	9	9	9	25	25	9	9			
MIN	0.5	0.5	0.5	0.5	0.0094	0.0096	0.00	0.00			
MAX	2.5	2.5	3.2	3.2	0.0240	0.0340	3.70	3.70			
MEDIAN	1.6	1.6	1.0	1.0	0.0112	0.0117	1.00	1.00			
AVERAGE	1.6	1.6	1.2	1.2	0.0120	0.0133	1.42	1.42			
OUTFALL 004											
BEGIN DATE		9/30/99		9/30/99	9/30/99	9/30/99					
END DATE		6/30/01		6/30/01	6/30/01	6/30/01					
NUMBER OF DATA POINTS		17		17	17	17					
MIN		8.4		8.4	0.0074	0.0255					
MAX		1001.0		342.0	0.0910	1.4930					
MEDIAN		487.0		46.9	0.0281	0.3990					
AVERAGE		451.4		74.6	0.0362	0.4723					

Table A2. Summary of DMR data for the City of Norphlet.

Norphlet											
	Ammonia (mg/L)		TSS(mg/L)		FLOW (Mgd)		CBOD5(mg/L)		DO (mg/L)	Sulfates (mg/L)	
	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	MIN	AVG	MAX
BEGIN DATE	9/30/99	9/30/99	9/30/99	9/30/99	9/30/99	9/30/99	9/30/99	9/30/99	9/30/99		
END DATE	7/31/01	7/31/01	7/31/01	7/31/01	7/31/01	7/31/01	7/31/01	7/31/01	8/31/01		
NUMBER OF DATA POINTS	12	12	18	18	19	19	18	18	8		
MIN	6.90	6.90	1.6	2.0	0.0177	0.0406	2.0	2.0	1.90		
MAX	0.10	0.10	71.7	78.0	0.5414	0.6823	8.0	8.0	4.47		
MEDIAN	9.70	10.80	6.3	10.0	0.0893	0.1811	4.3	5.0	3.00		
AVERAGE	3.28	4.20	13.3	16.4	0.1246	0.2577	4.5	5.1	3.08		

Table A3. Summary of DMR data for Wildwood Trailer Park.

Wildwood Trailer Park											
	Ammonia (mg/L)		TSS(mg/L)		FLOW (Mgd)		CBOD5(mg/L)		DO (mg/L)	Sulfates (mg/L)	
	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	MIN	AVG	MAX
BEGIN DATE	10/31/99	10/31/99	9/30/99	9/30/99	9/30/99	9/30/99	9/30/99	9/30/99	10/31/99		
END DATE	7/31/01	7/31/01	6/30/01	6/30/01	8/31/01	8/31/01	6/30/01	6/30/01	7/31/01		
NUMBER OF DATA POINTS	8	8	8	8	23	23	8	8	4		
MIN	0.10	0.10	2.0	2.0	0.0028	0.0115	2.0	2.0	2.00		
MAX	7.80	7.80	22.2	53.0	0.0495	0.0504	6.0	6.0	4.69		
MEDIAN	1.30	1.30	9.0	9.0	0.0261	0.0288	3.5	3.5	2.95		
AVERAGE	2.80	2.80	10.4	14.3	0.0269	0.0319	3.7	3.7	3.15		

APPENDIX B

Summary of ADEQ Water Quality Data

Table B1. Summary of In-Stream Chloride Data.

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D	OUA0137E	OUA0137H	OUA0137F	OUA0137G	OUA0137I
Period of Record for statisitics	1997 March to December								
Number of samples	1	1	1	1	5	4	4	5	1
MIN	25.498	27.92	254.4	771	19.0	41.8	23.8	18.3	16.475
MAX	NA	NA	NA	NA	46.7	77.9	70.1	31.4	NA
MEDIAN	NA	NA	NA	NA	35.1	63.4	33.3	22.9	NA
# above standards	1	1	1	1	4	3	4	3	0
% above standards	100	100	100	100	80	75	100	60	0

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D
Period of Record for statisitics	1995 -1996 January to July			
Number of samples	11	11	10	11
MIN	20.1	15.0	17	170
MAX	71.9	63.6	1160	2970
MEDIAN	34.1	25.5	293	1020
# above standards	11	8	9	11
% above standards	100.0	72.7	90.0	100.0

Table B2. Summary of In-Stream Sulfate Data.

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D	OUA0137E	OUA0137H	OUA0137F	OUA0137G	OUA0137I
Period of Record for statisitics	1997 March to December								
Number of samples	1	1	1	1	5	4	4	5	1
MIN	73.6	50.8	70.9	1.7	3.98	184	49.8	12.5	12
MAX	NA	NA	NA	NA	16.2	553	412	74.2	NA
MEDIAN	NA	NA	NA	NA	12.7	233	77.1	38.6	NA
# above standards	1	1	1	0	0	4	4	1	0
% above standards	100	100	100	0	0	100	100	20	0

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D
Period of Record for statisitics	1995 -1996 January to July			
Number of samples	11	11	10	11
MIN	47.6	33.4	9.3	2.3
MAX	700	652	125	11.6
MEDIAN	124	41.7	41.7	7.4
# above standards	11	9	5	0
% above standards	100.0	81.8	50.0	0.0

Table B3. Summary of In-Stream TDS Data.

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D	OUA0137E	OUA0137H	OUA0137F	OUA0137G	OUA0137I
Period of Record for statisitics	1997 March to December								
Number of samples	1	1	1	1	5	4	4	5	1
MIN	303	229	675	1562	104	734	307	163	131
MAX	NA	NA	NA	NA	174	1769	1373	284	NA
MEDIAN	NA	NA	NA	NA	144	1238	355	216	NA
# above standards	1	1	1	1	4	4	4	5	0
% above standards	100	100	100	100	80	100	100	100	0

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D
Period of Record for statisitics	1995 -1996 January to July			
Number of samples	11	11	10	11
MIN	206	159	496	780
MAX	1589	1447	2000	5231
MEDIAN	440	393	659	1704
# above standards	11	11	10	11
% above standards	100.0	100.0	100.0	100.0

Table B4. Summary of In-Stream Ammonia Nitrogen Data.

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D	OUA0137E	OUA0137H	OUA0137F	OUA0137G	OUA0137I
Period of Record for statisitics	1997 (PC&E) March to December								
Number of samples	1	1	1	1	5	4	4	5	1
MIN	11	5.57	0.187	0.165	0.20	12.66	6.80	0.03	<0.05
MAX	NA	NA	NA	NA	0.43	246	56.9	114	NA
MEDIAN	NA	NA	NA	NA	0.30	32.45	22.9	4.64	NA

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D	OUA0137E	OUA0137H	OUA0137F	OUA0137G
Period of Record for statisitics	1997(EPA) March to December							
Number of samples	NA	NA	NA	NA	5	4	4	5
MIN	NA	NA	NA	NA	1	40.8	20.4	0.4
MAX	NA	NA	NA	NA	9.6	360	72	34
MEDIAN	NA	NA	NA	NA	1.2	55.2	39.2	13.2

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D
Period of Record for statisitics	1995 -1996(PC&E) January to July			
Number of samples	11	11	10	11
MIN	5.55	2.25	0.06	0.06
MAX	54.1	48.3	4.74	0.71
MEDIAN	20.4	11.3	0.22	0.06

APPENDIX C

Figures 3.1 Through 3.3

Figure 3.1 Chloride Concentrations Measured in EDCC Tributary During 1995-1997.

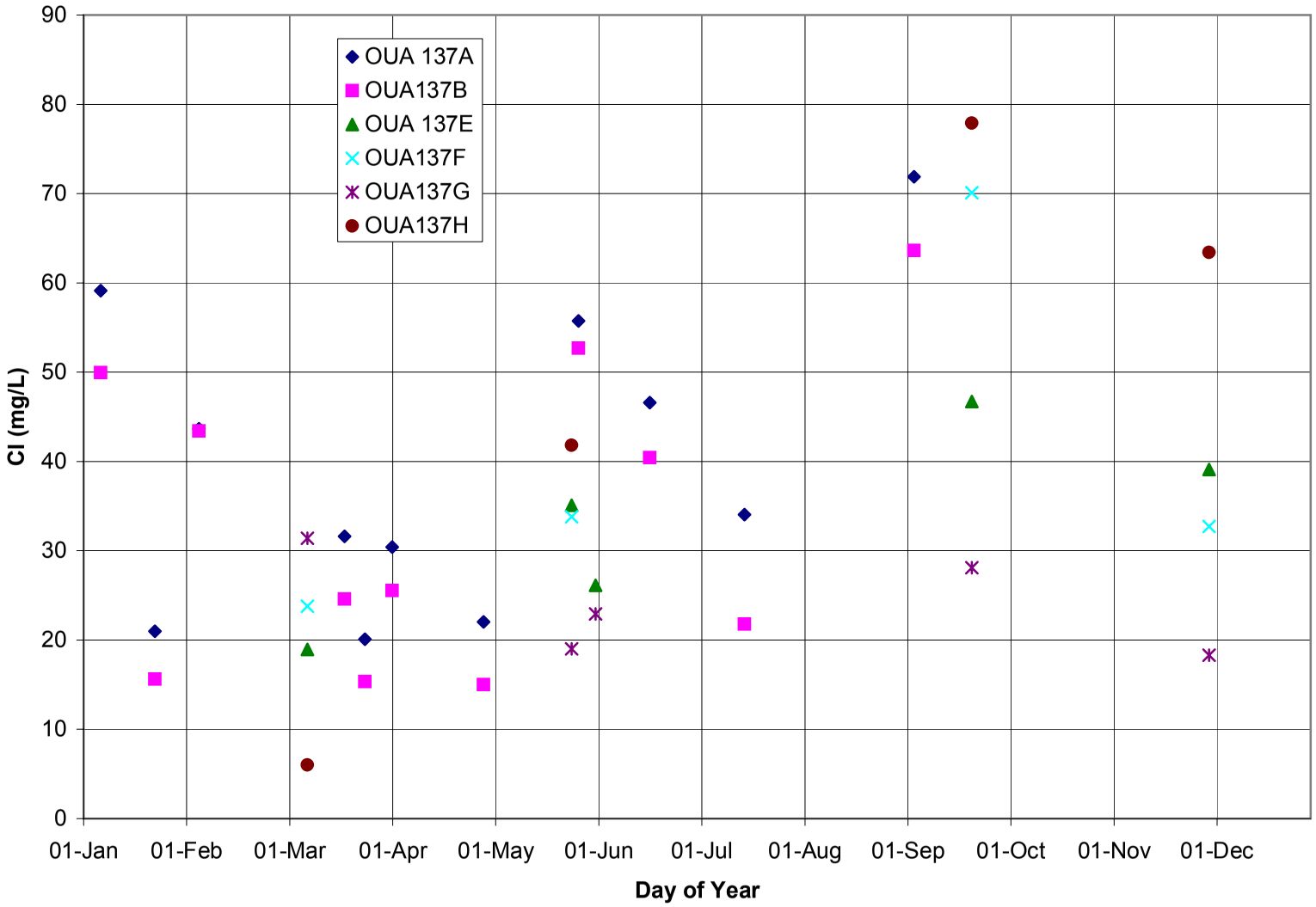


Figure 3.2 Sulfate Concentrations Measured in EDCC Tributary During 1995-1997.

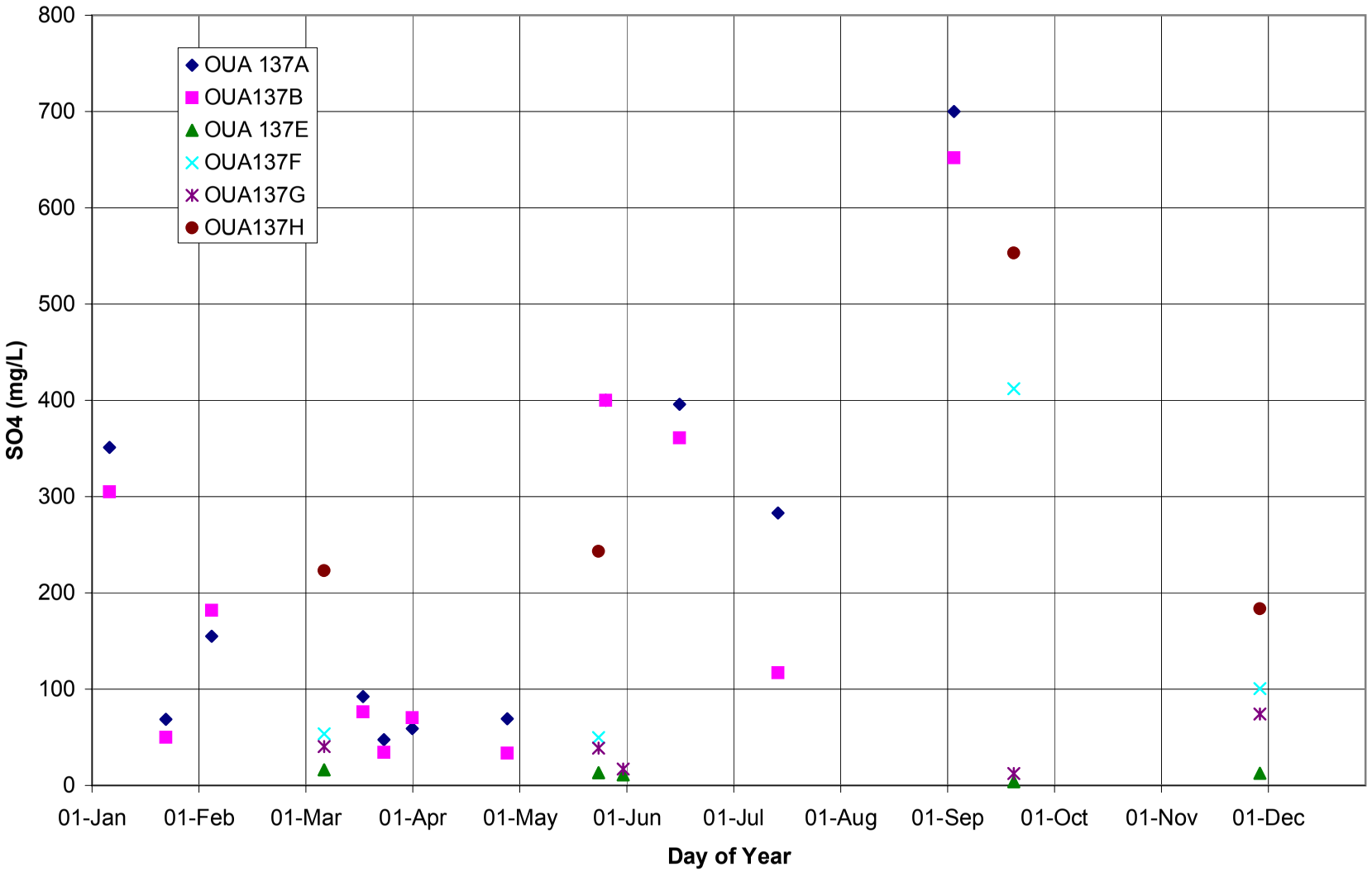
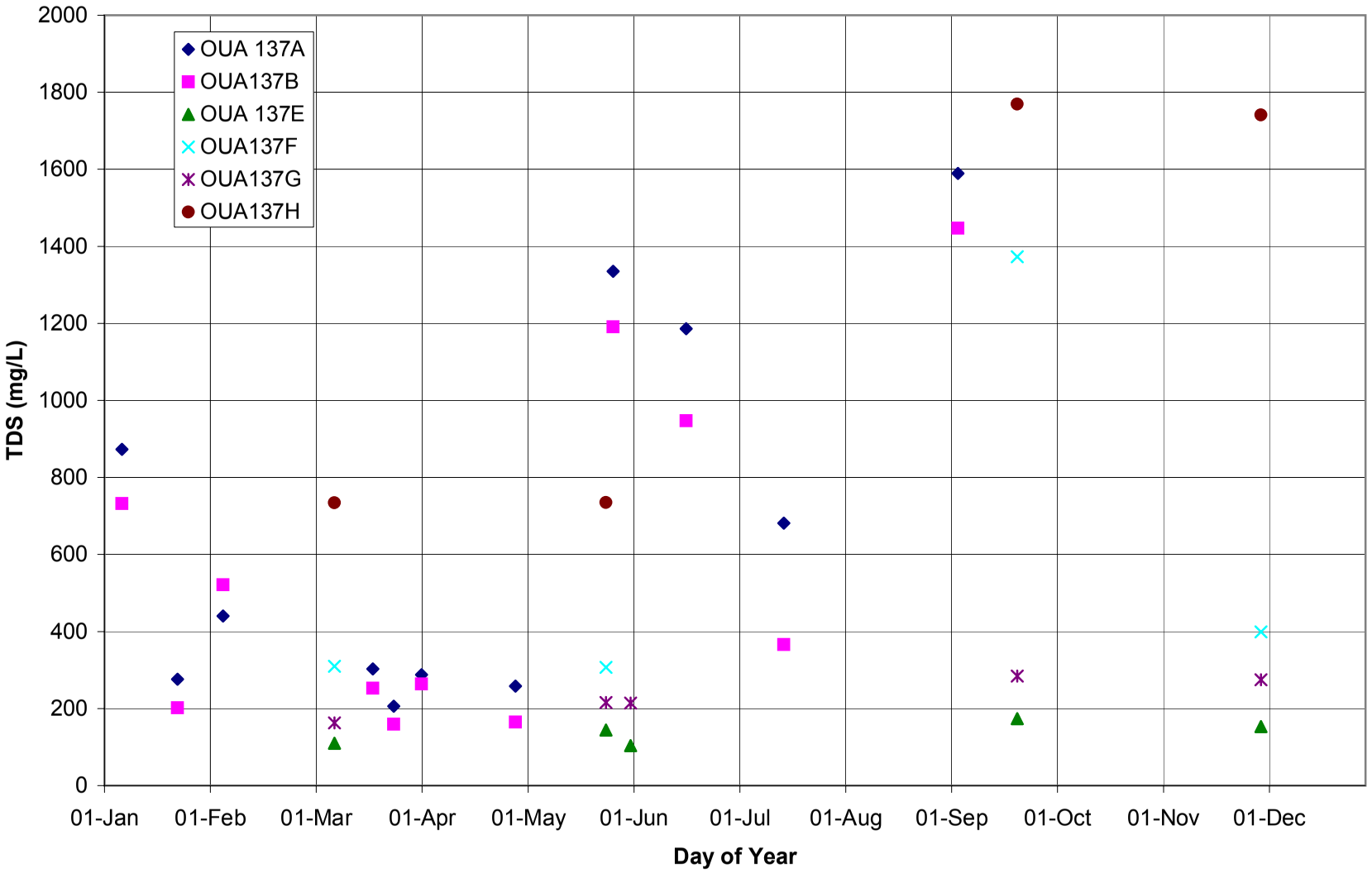


Figure 3.3 TDS Concentrations Measured in EDCC Tributary During 1995-1997.



APPENDIX D

Dissolved Mineral TMDL Calculations for ELCC Tributary

TABLE D.1. TOTAL **CURRENT** LOADS OF DISSOLVED MINERALS FOR ELCC TRIBUTARY

Measured concentrations at Station OUA137B:
(near mouth of ELCC Tributary, but upstream of City of Norphlet STP loading)

	Chlorides (mg/L)	Sulfates (mg/L)	TDS (mg/L)
1/24/95	15.6	50.0	202
3/21/95	24.6	76.4	253
4/4/95	25.5	70.4	264
9/5/95	63.6	652	1447
1/8/96	49.9	305	732
2/6/96	43.4	182	521
3/26/96	15.3	34.4	159
4/30/96	15.0	33.4	165
5/28/96	52.7	400	1191
6/18/96	40.4	361	947
7/16/96	21.8	117	366
6/3/97	27.9	50.8	229
Averages:	33.0	194.4	540

Calculation of flow and loads at mouth of ELCC Tributary:

Avg annual runoff for USGS gage on Smackover Creek = 15.0 in/yr
Total drainage area for ELCC Tributary at mouth = 22.54 mi2

Average annual streamflow for ELCC Tributary at mouth = 16.10 MGD
(Flow = Runoff, in/yr * Drainage area, mi2 * conversions)

Average annual loads for ELCC Tributary w/o City of Norphlet STP loads:
(Load = Flow, MGD * Conc, mg/L * 8.34)

Chlorides =	4431	lbs/day	(using OUA137B concs)
Sulfates =	26103	lbs/day	(using OUA137B concs)
TDS =	72508	lbs/day	(using OUA137B concs)

Flow and concentrations for City of Norphlet STP:

Design flow =	0.18	MGD	(from PCS)
Typical chlorides concentration =	70	mg/L	(from literature)
Typical sulfates concentration =	45	mg/L	(from literature)
Typical TDS concentration =	500	mg/L	(from literature)

Average annual loads for City of Norphlet STP:

Chlorides =	105	lbs/day
Sulfates =	68	lbs/day
TDS =	751	lbs/day

Average annual current loads for ELCC Tributary at mouth:

Chlorides =	4536	lbs/day
Sulfates =	26171	lbs/day
TDS =	73259	lbs/day

FILE: R:\PROJECTS\2110-550\TMDL_ELCC_MINERALS.XLS

TABLE D.2. TOTAL **ALLOWABLE** LOADS (TMDLs) OF DISSOLVED MINERALS FOR ELCC TRIBUTARY

Maximum naturally occurring levels:	Chlorides =	14	mg/L	(Reg 2, page 5-11)
	Sulfates =	31	mg/L	(Reg 2, page 5-11)
	TDS =	123	mg/L	(Reg 2, page 5-11)

For chlorides and sulfates, standards are 1/3 increase or 15 mg/L increase, whichever is less, over maximum naturally occurring levels. For TDS, standard is maximum naturally occurring level plus sum of increases in chlorides and sulfates (over maximum naturally occurring levels). (Reg 2, Section 2.511)

Water quality standards:	Chlorides =	19	mg/L
	Sulfates =	41	mg/L
	TDS =	138	mg/L

Average annual streamflow for ELCC Tributary at mouth = 16.10 MGD (from Table D.1)

Average annual allowable loads (TMDLs) for ELCC Tributary at mouth:

(Load = Flow, MGD * Conc, mg/L * 8.34)	Chlorides =	2551	lbs/day	Note: Values in shaded
	Sulfates =	5505	lbs/day	cells used in Table 4.1
	TDS =	18530	lbs/day	

FILE: R:\PROJECTS\2110-550\TMDL_ELCC_MINERALS.XLS

TABLE D.3. DISSOLVED MINERAL LOADS FOR SOURCES **NOT TARGETED** FOR REDUCTION

The following TMDL components are calculated here:
LA for background sources
WLA for Wildwood Trailer Park
WLA for City of Norphlet

Concentrations for background sources (based on reference stream data):

Chlorides =	5	mg/L	(from CPP)
Sulfates =	13	mg/L	(from CPP)
TDS =	67	mg/L	(from CPP)

Average annual flow for ELCC Tributary at mouth = 16.10 MGD (from Table D.1)

Average annual loads for background sources:

Chlorides =	671	lbs/day	Note: Values in shaded
Sulfates =	1746	lbs/day	cells used in Table 4.1
TDS =	8996	lbs/day	

Typical concentrations for Wildwood Trailer Park and City of Norphlet:

Chlorides =	70	mg/L	(from literature)
Sulfates =	45	mg/L	(from literature)
TDS =	500	mg/L	(from literature)

Design flows for Wildwood Trailer Park and City of Norphlet:

Wildwood Trailer Park =	0.031	MGD	(from PCS)
City of Norphlet =	0.18	MGD	(from PCS)

Average annual loads for Wildwood Trailer Park:
(Load = Flow, MGD * Conc, mg/L * 8.34)

Chlorides =	18	lbs/day
Sulfates =	12	lbs/day
TDS =	129	lbs/day

Note: Values in shaded cells used in Table 4.1

Average annual loads for City of Norphlet:

Chlorides =	105	lbs/day
Sulfates =	68	lbs/day
TDS =	751	lbs/day

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TABLE D.4. DISSOLVED MINERAL LOADS FOR SOURCES **TARGETED** FOR REDUCTION

The following TMDL components are calculated here:
WLA for ELCC non-stormwater outfalls
LA for ELCC stormwater outfalls
LA for man-induced nonpoint sources
Margin of safety

	Chlorides (lbs/day)	Sulfates (lbs/day)	TDS (lbs/day)	
Total CURRENT load for 3 targeted sources combined :				
Total current load for ELCC Tributary at mouth	4536	26171	73259	(from Table D.1)
minus background load	-671	-1746	-8996	(from Table D.3)
minus City of Norphlet WLA	-105	-68	-751	(from Table D.3)
minus Wildwood Trailer Park WLA	-18	-12	-129	(from Table D.3)
equals total current load for 3 targeted sources:	3742	24345	63383	
Total ALLOWABLE load for 3 targeted sources combined :				
TMDL for ELCC Tributary at mouth	2551	5505	18530	(from Table D.2)
minus background load	-671	-1746	-8996	(from Table D.3)
minus City of Norphlet WLA	-105	-68	-751	(from Table D.3)
minus Wildwood Trailer Park WLA	-18	-12	-129	(from Table D.3)
Totals:	1757	3679	8654	
times 90% (to incorporate margin of safety)	x 90%	x 90%	x 90%	
equals total allowable load for 3 targeted sources:	1581	3311	7789	
Margin of safety (MOS):				
Totals from above (before multiplying by 90%)	1757	3679	8654	
times 10%	x 10%	x 10%	x 10%	
equals margin of safety	176	368	865	
Uniform percent reduction for 3 targeted sources:				
(current load - allowable load) / current load =	57.7%	86.4%	87.7%	

Note: Values in shaded cells used in Table 4.1

Now, take the total allowable load for 3 components combined and divide it up proportional to the current loads for each of the 3 components:

Current loads for each of these 3 components:				
ELCC non-stormwater outfalls	628	3698	10890	(from Table D.5)
ELCC stormwater outfalls	173	243	5169	(from Table D.6)
Man-induced nonpoint sources	2941	20404	47324	(from Table D.7)
Percentage of combined load for each of 3 components:				
ELCC non-stormwater outfalls	16.8%	15.2%	17.2%	
ELCC stormwater outfalls	4.6%	1.0%	8.2%	
Man-induced nonpoint sources	78.6%	83.8%	74.7%	
Totals:	100.0%	100.0%	100.0%	
ALLOWABLE loads for 3 targeted sources:				
ELCC non-stormwater outfalls	265	503	1338	
ELCC stormwater outfalls	73	33	635	
Man-induced nonpoint sources	1243	2775	5816	
Totals:	1581	3311	7789	

Note: Values in shaded cells used in Table 4.1

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TABLE D.5. CURRENT LOADS OF DISSOLVED MINERALS FOR ELCC NON-STORMWATER OUTFALLS

		chlorides (mg/L)		sulfates (mg/L)		TDS (mg/L)	
		001	003	001	003	001	003
DMRs	9/30/99			188			
	11/30/99			485			
	1/31/00			467			
	2/29/00			398			
	4/30/00			246			
	5/31/00			184			
	6/30/00			252			
	7/31/00			219			
	9/30/00			257			
	10/31/00			259			
	11/30/00			243			
	12/31/00			191			
	1/31/01			142			
	2/28/01			121			
	3/31/01			75			
	4/30/01			117			
	6/30/01			154			
	9/30/01			299			
FTN	2/27-28/90			150			
	3/26-27/90	26	11	190	44	500	220
	9/19/90	68	35	420	29	990	300
	4/10-11/91	33	16	190	50	650	460
	4/10-11/91**	35	7	255	50	669	423
Average concs (mg/L) =		40.5	17.3	239.2	43.3	702	351
Design flows (MGD) =		1.85	0.02	1.85	0.02	1.85	0.02
Loads (lbs/day) =		625	3	3691	7	10831	59
Loads (lbs/day) for both outfalls combined = (used in Table D.4)		628		3698		10890	

**analyzed by ELCC

Note: Load, lbs/day = Flow, MGD * Conc, mg/L * 8.34

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TABLE D.6. CURRENT LOADS OF DISSOLVED MINERALS FOR ELCC STORMWATER OUTFALLS

		chlorides (mg/L)					sulfates (mg/L)						TDS (mg/L)				
		002	004	005	006	007	002	004	005	006		007	002	004	005	006	007
DMRs	8/2/93			7.3	31.0	30.0			124.0	42.5	42.5	78.0					
	6/6/94			40.0	35.7	31.6			51.0	< 1.0	0.5	49.0					
	6/16/96			25.0	27.0	4.0			149.0	50.0	50.0	129.0					
	6/26/97			24.5	20.0	27.0			54.0	111.0	111.0	12.0					
	5/26/98			24.7	18.4	9.7											
	6/21/00			1.4	10.8	20.1			10.8	5.3	5.3	99.5					
	6/5/01			25.1	6.3	46.7			2.5	47.2	47.2	534.0					
FTN	2/27-28/90							30.0									
	3/26-27/90		16					70.0						1500			
	9/19/90		790					4.0						1700			
	4/10-11/91		140					360.0						2300			
	4/10-11/91**		161					18.0						2013			

**analyzed by ELCC

	chlorides (mg/L)	sulfates (mg/L)	TDS (mg/L)
Average conc. (mg/L) for each parameter =	62.9	88.3	1878

Size of manufacturing area at ELCC facility = 300 acres (from FTN 1991)

Avg annual runoff for USGS gage on Smackover Creek = 15.0 in/yr (from Table D.1)

Avg annual flow from manufacturing area at ELCC = 0.33 MGD (drainage area * runoff * conversions)

Avg ann'l loads for ELCC stormwater outfalls: (used in Table D.4)	Chlorides =	173	lbs/day
	Sulfates =	243	lbs/day
	TDS =	5169	lbs/day

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TABLE D.7. CURRENT MAN-INDUCED NPS WATERSHED LOADS FOR ELCC TRIBUTARY

	Chlorides (lbs/day)	Sulfates (lbs/day)	TDS (lbs/day)	
Total current load for 3 targeted sources	3742	24345	63383	(from Table D.4)
minus ELCC non-stormwater current load	-628	-3698	-10890	(from Table D.5)
minus ELCC stormwater current load	-173	-243	-5169	(from Table D.6)
equals current man-induced NPS load (used in Table D.4)	2941	20404	47324	

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APPENDIX E

Documentation of QUAL2E Model for ELCC Tributary

APPENDIX E
IS AVAILABLE FROM EPA
UPON REQUEST

APPENDIX F

Ammonia TMDL Calculations for ELCC Tributary

TABLE F.1. AMMONIA TOXICITY CALCULATIONS FOR EDCC TRIBUTARY

Equations are from 1999 Update of Ambient Water Quality Criteria for Ammonia (EPA-822-R-99-014, Dec. 1999).

Use chronic criterion when fish early life stages are present (as mentioned on page 88, this is the same as CCC for early life stages absent when temp > 15°C)

$$CCC, \text{ in mg N/L} = [0.0577/(1+10^{7.688-pH}) + 2.487/(1+10^{pH-7.688})] * MIN [2.85, 1.45*10^{0.028*(25-T)}]$$

Note: CCC is the Chronic Criterion Concentration

pH values used in these calculations are average values for Station OUA137A (see data below). Temperature values used in these calculations are based on ADEQ Reg 2 (water quality standards).

Season	Average pH (su)	Temperature (°C)	Calculated CCC (mg N/L)
Summer	6.58	30.0	2.43
Winter	6.40	22.0	4.17

pH values for Station OUA137A (downstream of EDCC outfalls):

Summer (May - Oct):

Date	Value
9/5/95	6.60
5/28/96	6.42
6/18/96	6.83
7/16/96	6.08
6/3/97	6.99
Average:	6.58

Winter (Nov - Apr):

Date	Value
1/24/95	6.62
3/21/95	6.82
4/4/95	6.75
1/8/96	6.15
2/6/96	6.67
3/26/96	5.88
4/30/96	5.91
Average:	6.40

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TABLE F.2. AMMONIA MASS BALANCE CALCULATIONS FOR ELCC TRIBUTARY

Note: Shaded cells are used in Table 4.2

	City of Norphlet	Wildwood Trailer Park	ELCC Outfalls 001 & 003	Data Source / Comments
Summer:				
Upstream flow (Qu, MGD)	0	0	0	from 1991 FTN report
Upstream conc. (Cu, mg/L)	0.32	0.32	0.32	avg for OUA137E (from Table F.3)
Upstream load (Lu, lbs/day)	0	0	0	Lu = Qu * Cu * 8.34
Effluent flow (Qe, MGD)	0.18	0.031	1.87	Norphlet and Wildwood flows from PCS ELCC flows from mass and conc. limits
Downstream flow (Qd, cfs)	0.18	0.031	1.87	Qd = Qu + Qe
Downstream conc. (Cd, mg/L)	2.43	2.43	2.43	maximum allowable (from Table F.1)
Downstream load (Ld, lbs/day)	3.65	0.63	37.9	Ld = Qd * Cd * 8.34
Allow. effluent load (Le, lbs/day)	3.65	0.63	37.9	Le = Ld – Lu
Allow. effluent conc. (Ce, mg/L)	2.43	2.44	2.43	Ce = Le / Qe / 8.34
Current effl. conc. (Ce1, mg/L)	0.53	0.08	103.6	medians of DMR data (from Table F.4)
Percent reduction req'd (PR)	none	none	97.7%	PR = (Ce1 - Ce) / Ce1
Winter:				
Upstream flow (Qu, MGD)	0.646	0.646	0.646	from 1991 FTN report
Upstream conc. (Cu, mg/L)	0.32	0.32	0.32	avg for OUA137E (from Table F.3)
Upstream load (Lu, lbs/day)	1.72	1.72	1.72	Lu = Qu * Cu * 8.34
Effluent flow (Qe, MGD)	0.18	0.031	1.87	Norphlet and Wildwood flows from PCS ELCC flows from mass and conc. limits
Downstream flow (Qd, cfs)	0.826	0.677	2.516	Qd = Qu + Qe
Downstream conc. (Cd, mg/L)	4.17	4.17	4.17	maximum allowable (from Table F.1)
Downstream load (Ld, lbs/day)	28.73	23.54	87.5	Ld = Qd * Cd * 8.34
Effluent load (Le, lbs/day)	27.01	21.82	85.78	Le = Ld – Lu
Allow. effluent conc. (Ce, mg/L)	17.99	84.4	5.5	Ce = Le / Qe / 8.34
Current effl. conc. (Ce1, mg/L)	0.53	0.08	103.6	medians of DMR data (from Table F.4)
Percent reduction req'd (PR)	none	none	94.7%	PR = (Ce1 - Ce) / Ce1

Total upstream loads for all 3 sources:	Summer =	0	lbs/day
	Winter =	5.16	lbs/day

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TABLE F.3 UPSTREAM AMMONIA CONCENTRATIONS FOR ELCC TRIBUTARY

Measured ammonia data for Station OUA137E (upstream of ELCC outfalls):

Date	Value
3/10/97	0.30
5/27/97	0.40
6/3/97	0.20
9/22/97	0.25
12/1/97	0.43
Average:	0.32

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TABLE F.4. CURRENT EFFLUENT CONCENTRATIONS OF AMMONIA (based on available DMRs)

	ELCC Outfall 001 (mg/L)
Sep-99	57.4
Nov-99	63.1
Jan-00	103
Feb-00	118.6
Apr-00	106.4
May-00	70.3
Jun-00	90.1
Jul-00	86.9
Sep-00	57.9
Oct-00	88
Nov-00	99
Dec-00	201
Jan-01	280
Feb-01	246
Mar-01	125
Apr-01	149
Jun-01	118
Sep-01	123
Median:	104.7

	ELCC Outfall 003 (mg/L)
Oct-99	1.37
Jan-00	0.5
Apr-00	1.6
Jul-00	2.0
Oct-00	0.5
Jan-01	1.11
Apr-01	< 0.5
Jul-01	< 0.5
Oct-01	< 0.5
Median:	0.50

Note: Non-detect values were set to half of the detection limit for averaging.

	City of Norphlet (mg/L)
Sep-99	1.27
Oct-99	0.65
Nov-99	0.04
Dec-99	0.10
Feb-00	0.01
Mar-00	17.90
May-00	15.18
Jun-00	2.38
Oct-00	0.40
May-01	0.40
Jun-01	6.20
Jul-01	0.19
Median:	0.53

	Wildwood Trailer Park (mg/L)
Oct-99	0.01
Jan-00	0.01
Apr-00	0.14
Jul-00	0.02
Oct-00	0.02
Jan-01	2.62
Apr-01	3.09
Jul-01	0.25
Median:	0.08

Design flow for Outfall 001 = 1.85 MGD
Design flow for Outfall 003 = 0.02 MGD

Flow-weighted median conc. for ELCC outfalls = 103.6 mg/L

FILE: R:\PROJECTS\2110-550\TMDL_ELCC_AMMONIA.XLS